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# Clinical Research for Health Effects of Air Pollution

S. Nagaoka

## Introduction

The fact that air pollutants exert adverse effects on the human body, particularly on respiratory organs has been widely conjectured, but the cause and effect relationship has not been clearly grasped. So far, research has been conducted primarily from the epidemiological standpoint. However, partly due to its methodological limitation, explanation of the correlation has not been made clearly in terms of cause and effect relationships as far as chronic obstructive lung diseases which are regarded as deeply related to air pollution are concerned.

When the living body is subjected to impairment by an abnormal environment, it is natural that a single abnormal environmental factor becomes the starting point for impairment, but it is considered likely that there exists a connection of several environmental factors which cause the occurrence of the impairment.

Among those many factors, the role played by the factors existing in the living body is considerably important.

In order to make clear the influence of air pollution on health, it is necessary to study various factors including the "host factor" of the living body. For this purpose, epidemiological methods and clinical research based on the results of those methods may be required.

On the basis of the foregoing, the Health Division of this Institute entrusted a group of experts on respiratory organs with the study of air pollution as to what kinds of effects are exerted on our respiratory organs.

The following articles are abstracts of the entrusted research reports.

## 1. Immuno-chemical Research on Effects of Air Pollution

(1) Relationships between concentration of $\alpha_1$-antitrypsin in blood and disposition:

It has been reported that suffering of pulmonary emphysema at a young age which occurs among families is related to a decrease of $\alpha_1$-antitrypsin in the blood. Namely, when an inflammatory change occurs in the lungs, white blood cells congregrate around its location and the white blood cells are destroyed.

When the white cells are destroyed, trypsin, which may cause the destruction of lung tissue, is separated. In a normal person, $\alpha_1$-antitrypsin, which inhibits the action of trypsin, exists in the blood, therefore the destruction of lung tissue does not occur. However, where there is a decrease or absence of $\alpha_1$-antitrypsin, the destruction of lung tissue and pulmonary emphysema tend to occur.

Under the circumstance where $\alpha_1$-antitrypsin in the blood decreases, lung disease is advanced by the action of air pollution. Namely, under the conjucture that it tends to receive the influence of air pollution, $\alpha_1$-antitrypsin in blood of 57 patients with chronic obstructive lung diseases who are receiving treatment at the Hospital of Tokyo University (male 33 and female 24) and 64 patients who are officially recognized as suffering from diseases related to air pollution in the Kawasaki District (male 31, female 33) and 205 university students and employees as a control group (male 164, female 41) were measured by precipitation reaction in gel.

The results of these measurement showed that an extremely small number of patients in the Kawasaki District did have a low $\alpha_1$-antitrypsin value, but in general, no significant difference was detected between the patients with obstructive lung disease and the control group.

From the foregoing result, it was not found that the value of $\alpha_1$-antitrypsin in blood relates to a susceptibility to the influence of air pollution.

(2) Research on occurrence of auto-immunological mechanism due to lung impairment by gaseous air pollutants:

It has been pointed out that an anti-lung body has been demonstrated in some patients with chronic lung diseases. Namely, the lung tissue undergoes degeneration and as a result, it acts on normal lung tissue as foreign body and produces adverse development of diseases. Thus, the possibility that in case gaseous air pollutants are inhaled, the lung tissue itself will undergo degeneration and act as a foreign body was researched in an animal experiment.

For example, a rat was exposed to 500 ppm sulfur dioxide for one hour each day for two days consecutively and the lung was extracted after a lapse of 24 hours. The removed lung was cut into pieces and they were applied to homogenizer to form an emulsion. The resulting emulsion was injected into 10 rats and their blood was extracted. A serum was separated, and a supernatant fluid was produced by centrifugation of the emulsion of the lung. This was used as an antigen and a blood cell agglutination reaction test was carried out.

The result of the test was negative and from the result of this study, it could not be proven that adverse development of lung disease was brought about on account of the action of foreign bodies and through

autoimmunological mechanisms, but further review of this problem will be required.

## 2. Effects of Air Pollution on Upper Air Ways

There have been several reports relating to the influence of air pollution on upper air ways (nose, pharynx, larynx), but so far there are many problems for which solutions have not been found.

When air enters the upper air ways, inpingement of the air flow by valecula and epiglottes was confirmed by a model experiment and examination as to whether cysts, which are sometimes observed in the vicinity of the epiglottis, are related to air pollution has been carried out, but it could not prove a pathological relationship between them.

So, in order to draw an accurate conclusion it is considered necessary to make examinations from various angles from now on.

Moreover, pathological analysis on larynx and trache of autopsy cases of patients with silicosis has been carried out and simultaneously, examinations have been carried out as to the influences caused by air pollution by referring to contact history with dust.

As a result, in case a respiratory organ is affected by dust or silica, it is suspected that the trache rather than larynx is affected and particularly bifurcation is remarkably affected. These findings coincide with the results of animal experiments.

As a method of protecting the upper air way from air pollution, in general, gargling is used, but with respect to the effect of gargling, particulately the effect on the larynx, it is hard to say that a clear statement can be made. The positional change of gargle water in oral cavity and pharynx was observed by motion picture using an image amplifier.

20 examples were observed and 10 examples of them were related to cases of tonsillectomy. The remaining 10 cases, without exception, were related to normal examples in which no surgical operation had been made to the oral cavity and pharynx.

It became clear that the gargle water remains in the oral cavity in 9 examples out of 10, and moves vertically in the oral cavity, but in the 10 examples where tonsillectomy had been performed, it partially drops into the hypopharynx and moves within the hypopharynx, without exception.

From the foregoing observation results, it is surmised that in a normal person, gargling can purify the oral cavity, but the hypopharynx is only partially purified.

Figure 1 Normal Mouth Canify

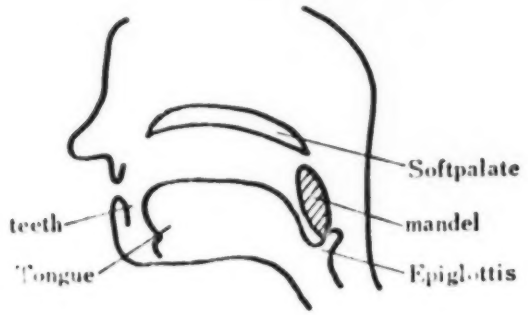



Figure 2 Normal Case

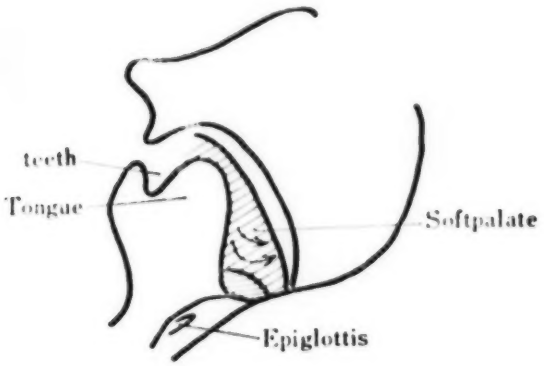
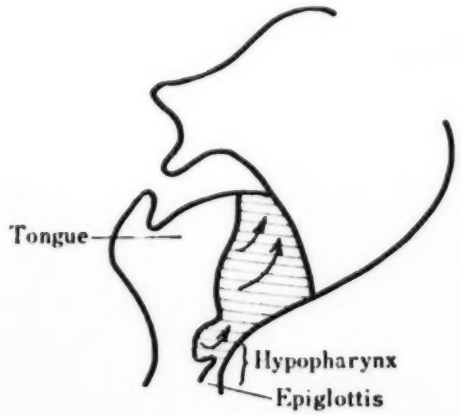



Figure 3 Case of Tonsillectomy



### 3. Research on the Relationship between Effect of Air Pollution and Children's Bronchial Asthma

It is thought that the influence of air pollution on growing children is a very important problem. Pulmonary function tests occupy an important position as a methodology for researching the influence of air pollution on respiratory organs. In the case of children, however, it is very difficult to obtain a normal value as there is a remarkable fluctuation (variation) in lung volume and various functions depending on age. Moreover, it is extremely difficult to carry out the examination itself depending again, on age.

Under these circumstances, the difficult work of finding a cause of influence of air pollution on growing respiratory organs makes it worth while to examine as many pupils as possible whose age permits such examination, collect the data every year, make comparative studies thereof, and at the same time compare the data with the fluctuation of air pollution conditions. Also it may be necessary to develop methods and equipment capable of measuring sensitively and simply the functional change influenced by air pollution.

For the foregoing purpose, measurement of vital capacity, forced expiratory volume 1 sec. and $FEV_{1.0}/FVC$ (Forced Vital Capacity) and also measurement of expiratory peak flow rate and respiratory resistance were carried out on pupils of third grade pupils and sixth grade pupils of an elementary school in Tokyo.

The summary of the results of this research is as follows:

The results of lung function test was shown in Table 1. $FEV_{1.0}/FVC$ is distributed in a range of 85 -90% among pupils of third grade and sixth grade who are regarded as normal and the value remains slightly lower than the normal distribution value of above 90% which is regarded as normal for those age groups, although it is not possible to say that these results are attributable to the influence of air pollution. This matter requires further examination.

When value of respiratory resistance is observed, it is distributed from the lowest point of 2.3 to the highest point of about 7.0, and the majority stays in a range of 3.0 -4.0 $CmH_2O/l/sec$. Judging from this result, it seems that a value of above 4.5 is too high to be regarded as the normal value zone.

When peak flow rate and value of respiratory resistance are observed, the results imply some form of latent constriction of the air way attributable to some cause (probably, influence of air pollution), but it may be necessary to make strict comparative studies of the degree of air pollution at these locations and times.

**Table 1**

Height: 125 ~ 130 cm ♂ 9 years ♀ 6 years

| School | Number of cases | Inspiratory capacity | | Expiratory reserve volume | | Forced vital capacity | | $FEV_{1.0}/FVC$ | | PFR | | Respiratory resistance | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | total | mean | total | mean | total | mean | total | mean | total | mean | total | mean |
| O | 15 | 20,312 | 1,354 | 7,255 | 484 | 26,932 | 1,767 | 1,278 | 85.2 | 2,518 | 168 | 66.8 | 4.45 |
| K | 15 | 19,281 | 1,285 | 6,281 | 419 | 24,067 | 1,604 | 1,289 | 85.9 | 2,678 | 179 | 63.9 | 4.26 |
| H | 15 | 20,050 | 1,337 | 7,542 | 503 | 27,060 | 1,804 | 1,288 | 85.9 | 3,290 | 213 | 57.8 | 3.85 |
| N | 12 | 16,277 | 1,356 | 5,866 | 489 | 20,139 | 1,682 | 1,066 | 88.8 | 2,523 | 210 | 60.2 | 5.02 |
| HO | 13 | 16,225 | 1,248 | 5,934 | 456 | 20,936 | 1,610 | 1,152 | 88.6 | 2,780 | 214 | 60.7 | 4.67 |
| S | 20 | 27,404 | 1,370 | 8,831 | 442 | 33,607 | 1,681 | 1,753 | 87.7 | 4,173 | 209 | 104.2 | 5.21 |
| SD | 18 | 24,825 | 1,379 | 8,159 | 453 | 30,787 | 1,710 | 1,609 | 89.4 | 3,981 | 217 | 82.9 | 4.60 |
| J | 22 | 36,441 | 1,429 | 9,039 | 502 | 41,367 | 1,871 | 2,011 | 91.4 | 5,105 | 235 | 101.9 | 4.63 |

When certain considerations are made on usefulness of various lung function tests, the use of the peak flow meter is simple and can be applied to children, but it has the drawback that there is a fluctuation in measured values, and also it tends to cause malfunctions due to moisture of respiratory air when measuring a large number of persons in a short time.

Spirometry is a fundamental method of lung function test, and is extremely useful in testing for $FEV_{1.0}/FVC$ but it requires cooperation of the persons to be tested. Also it is largely dependent on the technique used. Moreover, the instrument cannot be easily carried and has the drawback that it is not suitable for screening tests of a large number of persons in a limited time.

Finally, as a measuring instrument capable of accuracy and sensitivity to functional change appearing as the result of the influence of air pollution and also of making easy measurements, the respiratory resistance meter has appeared as a proper one at the present stage. Particularly, a direct reading type which has been recently developed is expected to be used more widely in the future.

**Conclusion:**

The problem of the effects of air pollution on human health is going to draw more attention from now on, and the necessity of grapsing the latent influences as accurately as possible is regarded as an important matter. Improvement of the methodology for grapsing the influence of air pollution with the progress of medical science as a background is a matter which ought to be given the highest priority. The performance of consigned research for 1971 is considered to have greatly contributed to the future development of research in this area.